TERMS OF REFERENCE

HYDROGEOLOGICAL STUDY TO EXAMINE GROUNDWATER SOURCES POTENTIALLY UNDER DIRECT INFLUENCE OF SURFACE WATER

Date: October 2001

PIBS 4167e

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for
Hydrogeological Study to Examine Groundwater Sources Potentially Under Direct Influence of Surface Water

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1.0 DEFINITIONS

The following Definitions apply throughout this document:

- **Communal Well** means a public water supply well subject to ODWS Section 52 for which an Engineers Report is required by regulation.
- **Director** means the Director of Environmental Assessment and Approvals Branch.
- **Groundwater Under Direct Influence of Surface Water (GUDI)** means groundwater having incomplete/undependable subsurface filtration of surface water and infiltrating precipitation.
- **Hydrogeological Study** means the study and report scoped by these Terms of Reference.
- **Hydrogeologist** means a person qualified to prepare a study in accordance with these terms of reference. Qualifications will be defined using the most current definition drafted by the Association of Professional Geoscientists of Ontario.
- **ODWS** means the **Ontario Drinking Water Standards**.
- **Regulation** means **O.Reg. 459/00** ("*Drinking Water Protection Regulation*") made under the Ontario Water Resources Act.
- **Surface Water** means water bodies (lakes, wetlands, ponds - including dug-outs), water courses (rivers, streams, drainage ditches), infiltration trenches and areas of temporary precipitation ponding.
- **Wellhead Protection** means the pro-active management of land to assess and mitigate potential risks posed to well water quality.

2.0 OBJECTIVES

To reduce the risk to human health attributable to disease causing microorganisms, Ontario has specified minimum treatment requirements for water works [1]. ***To ensure appropriate treatment is provided, the principal objective of this hydrogeological study is to determine whether a communal well should be managed as a supply "under the direct influence of surface water***".

Well water is Groundwater is Under Direct Influence of surface water (GUDI) where it has:

a) physical evidence of surface water contamination (eg. insect parts, high turbidity);
b) surface water organisms (e.g. campylobacter, aerobic spores, cryptosporidium, giardia).

Communal wells are "flagged" as potentially under the direct influence of surface water if they:

i) regularly contain Total Coliforms and/or periodically contain E. coli; or
ii) are located within approximately 50 days horizontal saturated travel time from surface water or are within 100 m (overburden wells) or 500 m (bedrock wells) of surface water (whichever is greater) **and** meet one or more of the following criteria:
    a) *Wells may be drawing water from an unconfined aquifer;*
    b) *Wells may be drawing water from formations within approximately 15m of surface;*
    c) *Wells are part of an enhanced recharge/infiltration project*;
    d) *When the well is pumped, water levels in surface water rapidly change or hydraulic gradients beside the surface water significantly increase in a downward direction;*
    e) *Chemical water quality parameters (such as temperature, conductivity, turbidity, total dissolved solids, pH, colour, oxygen) are more consistent with nearby surface water than local groundwater and/or if they fluctuate significantly and rapidly in response to climatological or surface water conditions.*

Potential GUDI wells will be considered to be under the direct influence of surface water unless this hydrogeological study proves otherwise to the satisfaction of the Director**.** In accordance with the Ontario Drinking Water Standards, water from GUDI wells must receive chemically assisted filtration and disinfection (or equivalent treatment process) unless this hydrogeological study shows, to the satisfaction of the Director, that the aquifer is providing effective *in situ* filtration (see section 3.5) [2].

3.0 GENERAL REQUIREMENTS

This hydrogeological study must include, but not necessarily be limited to, the following:
- Characterization of the hydrogeologic setting (see Section 3.1);
- Description of local surface water features (see Section 3.2);
- Assessment of the physical condition of on-site wells (see Section 3.3);
- Evaluation of source groundwater quality (see Section 3.4);
- Determination of need for filtration (see Section 3.5).

The study should use maps, air photos, well records, reports and water level/quality data. This data should be supplemented as appropriate with test pits, boreholes, monitoring wells, mini-piezometers installed in surface water, pumping tests, tracer tests, geophysical surveys, environmental isotopes (such as carbon-14, tritium, oxygen-18 and deuterium), and down hole investigations involving packers, video surveys, geophysics, flow meters and samplers [3].

In scoping study requirements, Hydrogeologists should consider that the report, including the recommendations in section 3.5, *should normally be completed within 3 months*. Questions regarding these Terms-of-Reference, appropriateness of planned work programs and other pre-submission consultation issues should be directed to an MOE hydrogeologist at the appropriate MOE Regional Office.

3.1 CHARACTERIZATION OF THE HYDROGEOLOGIC SETTING

The purpose of this part of the study is to characterize local conditions to determine if:
a) travel times from nearby surface water is significantly greater than 50 days;
b) well(s) extract water from deep water bearing zones which have no effective hydraulic connection to surface water sources; and/or
c) surface water organisms/contaminants are blocked from migrating to the wells due to effective filtration within the aquifer (see section 3.5), the presence of a competent aquitard that effectively protects the aquifer, or the configuration of the wells' zone of influence.

The study would typically include a description and assessment of:

i) Quaternary and Bedrock Geology: Show key topographic/geological features describing overburden thickness, composition, grain size distribution and sedimentary textures. For each bedrock lithologic unit, describe at an appropriate level of detail: thicknesses, composition, texture and known relevant weathering/alteration/structural features (fractures, joints, bedding planes, faults, and shear zones).

ii) Local hydrogeology: Define hydrogeologic features (aquitards and confined, unconfined and semi-confined aquifers) including details of their depth, thickness, lateral continuity, porosity, vertical/horizontal hydraulic gradients, hydraulic conductivity, transmissivity, storativity/specific storage and the location/nature of aquifer recharge supplying the well. Historical/seasonal groundwater level trends should be identified and pump test results / interpretations provided (including static water levels and pumping levels in the supply wells and relevant monitoring wells). Finally, the report must include the following descriptions of the study area: (1) a detailed map that is draw to scale, (2) hydrogeological cross-section with geology, borehole locations and water level measurements and (3) borehole logs with accurate geological descriptions.

iii) Surface Water/Well Interactions: interpret three dimensional flow patterns and assess hydraulic connections between aquifers and between water producing zones in wells and nearby surface water under pumping and non-pumping conditions. A map (with cross-sections) must be included showing the location of surface water, well(s) and 50-day capture zones for water supply wells.

3.2 DESCRIPTION OF LOCAL SURFACE WATER FEATURES

The purpose of this part of the study is to describe all surface water features in the vicinity of the supply well(s) and to quantify the potential risk that these features pose to supply well(s). The study should include, but not be limited to, a description of the:

a. local topography and location (UTM), type and size of local surface water features;
b. seasonal variations of surface water features and associated water levels or flow rates (based on field measurements, historical information, air photo interpretation etc);
c. surface water quality, including analysis of historic/seasonal trends;
d. surface runoff drainage patterns in the vicinity of the supply well(s);
e. description of the local sub-watershed surface water catchment area;
f. land uses in the surrounding catchment area that may affect the quality of surface water.

3.3 ASSESSMENT OF THE PHYSICAL CONDITION OF ON-SITE WELLS

The purpose of this part of the study is to determine whether supply well susceptibility to contamination from surface water sources can be mitigated by making structural changes to on-site supply, monitoring and test well(s) . For each well, the study shall describe:

a. Location [4], construction date, elevation, well depth, screened interval, casing depth, height above ground, describe any well pits and potential for flooding of the well site(s);

b. Compliance with O.Reg. 903 requirements, including the integrity of the well annular seal. *Corrective action must be taken immediately to rectify any construction/maintenance deficiencies that are found.* The hydrogeological study should then assess whether the corrective action eliminated surface water influences on the supply well(s).

c. Description of significant water-producing zones in wells, including their hydrogeologic characteristics, depth, yield, quality and susceptibility to contamination. This assessment should go beyond O.Reg. 903 requirements and should recommend any structural modifications that would reduce well susceptibility to potential contaminant sources. *If recommendations to waive treatment requirements are made based on these corrective measures, they must be carried-out immediately and their effectiveness assessed as part of the hydrogeological study.*

3.4 EVALUATION OF SOURCE GROUNDWATER QUALITY

The purpose of this section is to determine whether water quality reflects impacts from surface water. This discussion should include analysis of data included in the water supply system Engineer's Report and any relevant data collected during this study to:

i) determine whether any observed significant or rapid shifts in water quality reflect impacts from infiltrating surface water or are caused by geochemical reactions within the aquifer. This would include correlation of source water quality data with seasonal variations, observed historical trends, precipitation events and pump use;

ii) develop a clear conclusion as to whether source water quality is more closely representative of background groundwater or that of nearby surface water. This should include statistical comparison of water quality data and consideration of any correlations noted above;

Water quality characterization should include consideration of the usefulness of continuous data respecting electrical conductance, pH, turbidity, temperature along with water levels and rainfall.

3.5 DETERMINATION OF NEED FOR FILTRATION

The purpose of this section is to conclude whether supply wells are vulnerable to microbiological contamination from surface water sources and to make recommendations regarding whether there is a need to provide filtration. The hydrogeological study shall include a:

i) **conclusion clearly classifying each water supply well** as being either:
   a) under the direct influence of surface water; ***OR***
   b) not under the direct influence of surface water.
   If there is ***significant uncertainty****, Hydrogeologists should err on the side of public health and safety and consider wells to be vulnerable to direct surface water influence.*

ii) **clear conclusion indicating whether raw water is effectively filtered**. Raw water must not contain significant numbers of large particles which could shield embedded microbes from effective UV or chlorine disinfection. In order to conclude whether the aquifer is providing effective *in situ* filtration, all the following conditions must be met:
   a) particle count data must show that the water consistently contains significantly less than 100 particles per ml in the size range10 microns and greater in size;
   b) the hydrogeologist must confirm that the particle count is not likely to change during storm, season or other regular environmental changes; and
   c) the raw water is characterized by good microbiological quality.

   This information will be used by the Director to determine if filtration is required.

4.0 PREPARATION AND SUBMISSION OF A REPORT

i) The results of this study shall be compiled in a report which includes all supporting data (hydrogeological, chemical and bacteriological), maps, photographs and graphs.

ii) The report shall be prepared and signed by a qualified Hydrogeologist.

5.0 SUGGESTED REFERENCES

Engineering Report(s) for the Water Supply.

Ontario Drinking Water Regulations.

O.Reg 459/00 for "*Drinking Water Protection*" made under the Ontario Water Resources Act

O.Reg 903 for "*Water Wells Regulation*" made under the Ontario Water Resources Act

Procedure B13-3 "*Chlorination of Potable Water Supplies in Ontario*"

6.0 ENDNOTES:

1. The definition of a water works (communal well) is provided in the *Ontario Water Resources Act*. Wells must be constructed, maintained and abandoned in compliance with O.Reg 903. "**Springs**" are wells where works are made or equipment installed for collection or transmission of water that is likely to be used for human consumption (OWRA 35-1).

2. Even if physical, chemical and bacteriological raw well water quality has consistently met Drinking Water Standards, effective protection must be provided against organisms such as giardia which can rapidly appear in surface water. This can be done by proving that the supply well(s) receive subsurface filtration that is as effective and reliable as chemically assisted filtration or by installing appropriate treatment works (such as ultraviolet treatment).

3. All well technicians and contractors constructing or completing repairs on water wells must be licenced in accordance with O.Reg. 903.

4. All UTM coordinates should be referenced to the NAD83 datum. Information regarding the method of data collection and accuracy of the data must also be provided.